DOCUMENT RESUME

ED 340 337 IR 015 295

AUTHOR Shakirova, Dilyara; And Others
TITLE Content, Composition and Structure of Pedagogical Software and Problem-Solving Methods.
PUB DATE Sep 90
NOTE 15p.; Paper presented at the Soviet-American Symposium on Modern Teaching/Learning Technologies in Professional Education (1st, Anapa, USSR, September 9-16, 1990).
PUB TYPE Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Algorithms; *Computer Assisted Instruction; Computer Software; Creative Thinking; *Educational Strategies; Foreign Countries; Individualized Instruction; *Instructional Design; *Learning Processes; Microcomputers; Postsecondary Education; *Problem Solving; *Professional Training; Teaching Models
IDENTIFIERS USSR

ABSTRACT

This paper describes an approach to instruction and learning processes in professional training schools using microcomputers and computer assisted instruction (CAI). It is argued that the use of computers in education changes existing approaches to teaching and learning by focusing on the structure of the information being taught, the organization of the technology used to teach that information, and the differences among people learning the information. A teaching model is proposed that differentiates between the knowledge and skills that must be learned in professional training, focusing more on the general creative thinking and problem solving abilities rather than on specific subject domains. The modeling pedagogical software (MPS) is described as a CAI software program that helps students develop algorithmic problem solving skills involved in conducting scientific experiments. (It is noted that the investigatory method of solving problems, as opposed to the algorithmic method, is used primarily in instructional research.) The investigatory pedagogical software (IPS) reflects the structure and organization of investigatory studies and uses relevant subject content. The Computer Integrative Practicum (CIP) is described as an IPS system that integrates investigatory, creative, and professional skills using content in general and professional subjects. CIP also focuses on the complexity of the interaction between student and computer, the depth of integration of teaching and learning materials, and the interrelation of model and real experiment. The 15 references provided are in Russian. (DB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

ED340337

CONTENT, COMPOSITION AND STRUCTURE OF PEDAGOGICAL SOFTWARE AND PROBLEM-SOLVING METHODS

Dilyara Shakirova,
chief of CAI laboratory,
Ludmila Strukova,
Flyora Suphiyarova,
Irina Narykova,
research Associates of
CAI laboratory
Research Institute of SSE
USSR APS

120529S

BEST COPY AVAILABLE

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

D. Shakirova

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

CONTENT, COMPOSITION AND STRUCTURE OF PEDAGOGICAL SOFTWARE AND PROBLEM-SOLVING METHODS

Introduction

The main aim of this presentation is the description of approach to the teaching/learning process computerization in professional school taking into account the following factors:

-the general aims of teaching/learning and theoretical approaches to the content and organization of teaching/learning process, chosen according to them;

-the level of future professional utilization of computers by the students of the certain speciality (the category of computer user);

-the level of development of technical teaching/learning means and their didactic opportunities;

-the level of development of applied and pedagogical software.

The concrete organization of teaching/learning process depends on the great amount of technical, organizing and purely pedagogical conditions. At the same time it's possible to pick up such aspects of the contential and processional parts of teaching/learning process , that are determined by the authors of pedagogical software and make the definite requirements for organization of teaching and learning processes.

In this presentation we'll consider in details these very aspects, examining the opportunities of varying the composition and structure of computer programs for implementation of different teaching/learning strategies.

The main principles

1. There is the idea in the basis of our approach, that computer is not simply the new teahing/learning mean, but it is principally new mean. The c omputerization of teaching/ learning is a process that changes the existing approaches tc teaching/learning, it is the process of creating the new system with its own goals, theoretical base, way of organization, functioning and evaluation. And what's more,

the distinctive peculiarity of computerized teaching/learning process is not the choice of the "best", optimal strategy for everybody, but the opportunity on the basis of analysing the student's model to choose among the proposed strategies and teaching/learning means the most adequate for every student. Within this, not only teacher participates in the choosing process, but the student as well. Allthough, no dobt, that the choice of learning strategy is determined in a certain way by the programmer.

2. We point out as the general aims of teaching/learning the following: a) the development of creative thinking and individual person's abilities; b) the formation of professional knowledge, skills and competency; c) the formation of demand and abilities for self-education, self-evaluation and upgrading the professional competency.

The achievement of these goals is possible if taking it into account in all levels of development, implementation and evaluation of teaching/learning materials: learning manuals and teaching aids, didactic materials for classroom work, pedagogical software. Within this the hierarchic structure of aims is being built for each subsystems of teaching/learning materials. In more detailed way this point was discussed in our article /1/, considering the content of theoretical subjects.

The main peculiarity of professional school is characterized by two groups of subjects in its curriculum: general subjects and professional. From our point of view, the arguments and results of practice, concerning the aims, place and role of these groups, its specifics in the training of concrete specialist didn't succeed till now, because both groups were oriented on forming knowledge and skills with close enough content and by the similar ways. Even the fruitful idea of correlation of general and professional knowledge /2,3/ didn't make the principle innovations in the teaching/learning process and hardly made it different from the comprehensive school. We suggest to change the approach to the aims and role of general subjects in professional school. They must serve not only as informational base for professional subjects, but as the basis of the creative

thinking development, of mastering the methods of science, technological and technical methods and means, formation of learning experience. So, the first and the third aims from those, mentioned above, refer mostly to general and, in a way, to general-special subjects.

This approach leads to the special organization of teaching, learning and evaluating processes, appearing on the first plan, but not the totality of disciplinary knowledge and skills, that become obsolent rapidly enough.

We consider the theory of Problem solving teaching/learning to be didactical base, mostly adequate to our main principles. With this regard there is a need for further development of methods and ways of teaching and learning as its (the theory's) grounds. How can this approach be implemented by means of content, composition and structure of pedagogical software ?

Methods of science and teaching/learning, its correlation.

It is pointed out in our technology of projecting the pedagogical software, that the determination of proposed teaching/learning methods is the obligatory stage of projecting and it is realized by means of combination of binary methods - teaching and learning. And what's more, the teaching methods determine the program's structure while learning methods - its composition. The functions of teaching and learning, withtin this, are preserved but ways are considerably changed (look the table 1).

The choice of teaching/learning method is closely connected with the peculiarities of learning material. Here is only one aspect of this correlation - combination of general methods of scientific research in the content of courses and pedagogical software with methods and means of teaching/learning.

The mathematical modeling method (MMM) acquired the last years the status of general method of science. It was also promoted by the opportunity of using computer for solution of different kinds of scientific and practical problems by means of mathematical modeling. MMM now is used not only in such common, easily formalized areas as physics,

chemistry and various technical disciplines, but it is also fruitfully used in biology, medicine, sociology, linguistics and so forth.

So, this supports the point of view of many specialists in informatics who consider the notion "model" and methods of modeling to play the key role in the new informational technology, that penetrates all the spheres of modern society. This fact can be considered to be the first reason for necessity of using computer modeling in teaching/learning process in the system of secondary and professional education. Let's examine, in brief, the first reason before pointing out the second.

So, the wide application of computer modeling in science, technique and production requires the studying of this method, i.e. its introduction as contential component in such general and specialized disciplines as mathematics, informatics, automatic projection etc. And besides it doesn't mean the creation of some new inificated courses of computer modeling for all the categories of students, but the differentiation of knowledge and skills, connected with this method that must be formed with the regard for the future professional activity of students. Within such approach the students are usually devided into two groups: those who have to master the methodology of modeling and those, who must also be able to use it in their professional activity (future engineers, designers, applied mathematicians). To our opinion such division doesn't take into consideration the needs of specialized secondary education system, because its graduates in their professional activities will most probably use complete computer models for solving their practical tasks than create these models themselves. In this regard we consider the studying of computer modeling method in the system of professional education to be oriented on:

- mastering the MMM by the student;
- acquiring abilities to use complete computer models for solving problems connected with the sphere of future professional activities.

It's quite easy to forsee, that such general subjects as informatics, physics and chemistry are responsible for

solution of the first problem. The second problem can be solved efficiently also by means of general - technical and specialized subjects. Such approach makes it possible to realise the persistence in teaching this method, so knowledge, acquired on each stage of teaching/learning, becomes the ground for further improvement in mastering this method.

The second reason, that forces us to search for ways of using computer mathematical modeling in teaching/learning process of professional school is its great pedagogical potential. The description of phenomena and processes by means of computer models and the way of operating models creates the grounds for integrating the theory of problem solving teaching/learning and computer technique of teaching/learning. What are these opportunities? First of all it is the total realization of such functions of problem solving teaching/learning as:

- the increasing of scientific level and professional orientation (computer MMM makes it possible to draw together the methodology of educational and professional activities);

- the development of students' thinking (active forms of activity, that predominate while operating computer models or computer environment for modeling, make it possible to form and fix the students' thinking operations and certain styles of thinking);

- the formation of cognitive motivation (active, creative atmosphere while studying by means of computer models, feeling itself to be the participant of cognitive process and not the subject of pedagogical influence, all this promote preserving of instant interest in learning).

While speaking about realization of these problem solving teaching/learning functions within using simulation we can't, but remember the proceedings of Seymour Papert, the prominent American scientist, the specialist in computer-assisted teaching/learning junior scholars that have a great impact upon the formation of our principles, for instance, on cognitive psychological aspects of computer technology of teaching/learning.

However, as we know, each fruitful pedagogical idea (and

the idea of the development of computer-assisted teaching/learning on the basis of the theory of problem solving teaching/learning as well) must be embodied in concrete regulative standards of teaching/learning process organization. In this sense the theory of problem solving teaching/learning and its main didactical components, described in the proceedings of academician M. Makhmoutov, makes it possible to develop pedagogical software on the basis of computer modeling method and its didactic materials for teachers.

The creation of pedagogical software on the basis of computer modeling method is now widespread in the USSR and USA /10,11/. However, the most part of modeling pedagogical software (MPS) in the USSR is developed for the system of higher education /12,13/, because it isâbased on higher mathematics. There are now any developments concerning the implementation of MPS in the system of professional education, containing the solution of various professional problem solving tasks by means of MPS. We consider such trend in investigative activity to be strategic. In the present stage we developed the MPS complex for teaching physics, chemistry and special subjects with theoretical grounds (electrotechnics, the materials' processing). We'll try to describe the composition and structure of MPS and its opportunities in the aspect of realization of problem solving methods.

The MPS from the programmer' s standpoint includes the block of matchematical model (equation or system of equations describing object or process); block of model-made data, containing proposed parametres and characteristics of object or process; information block (interface of user); block of process' visualization with rich possibilities of computer graphics for representation of physical, chemical or technological processes in dynamics.

As for user (the student), MPS composition is the complex of different regimes: demonstration, teaching to conduct experiment. In future we plan to include in such programs the regime of data processing while working with model. The MPS structure makes it possible for user to change

the regimes and parametres of model within one regime.

The composition and structure of MPS, described above, determine the MPS using in teaching/learning process and its methods. The "display" experiment is the adequate way of using MPS. The content of such experiments can include:

- experimental aprobation of advancing hypothesis;
- the solution of computational problems;
- the carrying out of experiment for studying the ways of data representation and processing;
- the carrying out of experiment for creation of data bases for students.

We can make the conclusion, that computer models allow to use such productive problem solving methods as algorithmic and investigatory.

Let's turn to algorithmic method. It is characterised by the combination of instructive and stimulating teaching methods with practical and research learning methods. In the Table 1 the ways of binary methods in traditional (without computer) teaching/learning and concrete ways, realized through the composition and structure of pedagogical software (PS) are represented. Using computer in teaching/learning process leads to development of problem solving method in general and algorithmic in particular.

M. Makhoutov determines /14/ the algorithmic method as the system of regulative rules of learning organization on the basis of prescriptions and demonstration to students the algorithms of practical activity for acquiring knowledge, model and algorithm of operation. We consider algorithm to be the totality of elementary operations, that leads to the achievement of setting goals.

The notion of elementary operation is quite relative. The similar operations for one student can be elementary and for another - non-elementary. The teaching/learning process is characterised by the fact, that the student, while learning, developes his abilities, that's why the elementary operations must be individual for each student. It is necessary to determine the level of students' knowledge and operations and to reveal and analyse what is formed and non-formed.

It follows one of the main problems, appearing while realizing the algorithmic method and hence the corresponding teaching and learning methods in pedagogical software: how to work out the individual algorithm and then how to formalize it. This problem having been solved stage by stage and finally was reflected in three now existing types of programs.

1. The programs with the strict algorithm of activity. The individualization of this algorithm is being reached by means of varying different types of help with various levels of detalization.

2. The programs with flexible algorithm. The student self-independently forms the algorithm of activity, being guided by the program recommendations for its constructing.

3. The programs realizing the expert-heuristic approach with the usage of mathematical theory of sets.

However, while organizing such activity it's necessary to remember, that instructional research differes from the scientific one with its aims and correspondingly, with content, organization and technical possibilities. While scientific research is directed to the solution of fundamental scientific and applied problems, the instructional one is directed to the achievement of cognitive aims. The computer functions in the process of instructional research are specific and are supplemented, besides traditional, with illustrative and informational ones.

How is it possible to realize these computer functions in the process of organizing the instructional research activity? We consider, that it can be most efficiently implemented by means of specially organized, definitely structured investigatory pedagogical software (IPS). We can point out the following groups of peculiarities, that must be taken into account while developing and using the IPS:

- the peculiarities of content, its logic-structural representation (algoritm, the ways of its realization in the concrete program);

- the peculiarities of organization and conduction of investigatory studies, the place of computer in its structure and combination of computer functions in its different

stages.

The contential aspect.

The IPS content is chosen with the regard of the main criteria of choosing content for programming /5/. Besides, it's necessary to take into account the specific requirements:

- the integrative character of knowledge and skills, being utilized and formed during the studies;
- the quantitative character of the tasks, providing the formation of skills to operate with great amount of digital data, to use various statistics methods for data processing;
- availability of mathematical or strict enough qualitative description of investigative object, phenomena or process, that makes it possible to create mathematical or simulation model adequately reflecting its main parametres and properties; within this it's necessary to adhere to the principle of rational using of modeling methods, i.e. to model only those objects, phenomena and processes, that can't be experimented with, or innaccessible for observations in real conditions;
- providing for complete realization of computer technical and didactical possibilities.

When determining the content it's necessary to choose the themes, providing the possibility to solve simultaneously the professional and theoretical problems.

For example: What substances can be used for electro-chemical obtaining metals in laboratory and production?

It's necessary to use the corresponding material of three subjects for the solution of this problem: Chemistry, Physics and General Chemical Technology, and to use skills, having been formed in the course of Informatics and Computer Science. It's also necessary to take into account the different ways of solving the problem: theoretical, on the base of studying the mechanism of electrolysis; experimental, when carrying out model or real experiment; technological, by means of studying existing technologies of electro-chemical production. Each way in IPS is corresponded by the definite

"regime".

Logic-stuctural aspect.

The IPS content must be structured in such way, that makes it possible to meet the following demands:

- "poly-functioning", i.e. the possibility to implement almost all computer functions, technical and didactic;
- "adaptiveness", i.e. operating the student's activity with the regard of his level of mastering the learning material and his ability to use the acquired knowledge practically;
- "poly-regiming", that provides the possibility of free choice of consequence and ways of the problem solution, i.e. the teaching/learning strategy.

The processual aspect.

We consider, that investigatory method will be implemented most efficiently, if not only the pedagogical software but also the studies, where the IPS is used, are organized in the special way. It must be the complex of lessons, united with the common aim, common problem (that split in the concrete lesson on more narrow, particular ones), common structure, common contential and processial trends. We named such form of teaching/learning the Computer Integrative Practicum (CIP), as the computer is the central teaching/learning mean and the aim is to form the integrative system of skills, containing and uniting in itself investigatory, creative and professional skills on the base of integrated content of the general and professional subjects with physics-chemical grounds.

There is the generalized structure of the CIP lesson to be represented in the Table 2 with pointing out the stages, groups of skills being formed in the concrete stages and corresponding combinations of computer functions.

The program and topical planing of CIP can vary considerably with the regard of professions, changes in general and professional subjects, as the program has modular structure and serves for fixing, deepening and utilization of knowledge and skills, acquired while learning the systematic courses. In the CIP program, regardless its integrity, the leading subject is determined, in our case it is chemistry.

However, the notions, laws and facts from the adjacent subjects are used. And what's more, this correlation may be perspective as well as following one.

To our standpoint it is rational to devide CIP on two parts (the 1st and the 2nd courses), that differes with its problem solving level, the variety of ways of problem solution, the complexity of interaction with computer, the depth of integration of teaching/learning material, the interrelation of model and real experiment.

Finally, we see, that IPS, forming the composition and structure of CIP, determine at the same time its logic-structural base as well as its processial base.

REFERENCES

1. Шакирова Д., Суфиярова Ф. Особенности обучения химии с применением ЭВМ //Вопросы методики обучения химии и биологии в средних профтехучилищах: Сб. науч. тр. М., 1987 с. 54-68

2. Махмутов М. Взаимосвязь общего и профессионального образования //Советская педагогика, 1986, N6, с. 32-37

3. Башарин В. Проблема взаимосвязи общего и профессионального образования //Научно-педагогические основы взаимосвязи физики, математики и дисциплин профтехцикла в средних ПТУ. Сб. науч. тр. М., 1985. с. 3-23

4. Махмутов М. Теория и практика проблемного обучения. -Казань, 1972. - 551 с.

5. Шакирова Д. Проектирование программно-методического обеспечения для предметов физико-химического цикла //Информатика и образование. 1988. N4. с. 19-21

6. Самарский А. Математическое моделирование и вычислительный эксперимент //Вестник АН СССР. 1979. N5. с. 38-49

7. Белошапко В., Лесневский А. Основы информационного моделирования //Информатика и образование. 1989. N3. с. 17-24

8. Павлов С., Цилевич Б. Возможности применения метода математического моделирования для разработки педагогических программных средств //ЭВМ в образовании. Программное обеспечение. Рига: ЛатвГУ им. П. Стучки, 1988. с. 114-127

9. Пейперт С. Переворот в сознании: дети, компьютеры и плодотворные идеи. -М.: Педагогика, 1989. -224с.

10. Wilson J., Redish E. Using computer in teaching physics //Phys. T day. 1989. Vol. 42. N1. p. 34-41

11. Ogborn J. A microcomputer modeling system and the teaching of problem structure //Rech. didact. phys. Actes 1 atelier int. La Londeles Maures, 16 Juin - 13 Juil, 1983, 1984. p. 441-444

12. Осипов Н., Ким П. Поливариантное учебное моделирование движения в центральных полях //ЭВМ в учебном процессе ВУЗа: Межвузовский сборник науч. тр. - Новосибирск: НГУ, 1987. с. 20-28

13. Жаблон К., Симон Ж.-К. Применение ЭВМ для численного моделирования в физике. - М.: Наука, 1983. -235с.

14. Махмутов М. Методы проблемно-развивающего

обучения. // Методические рекомендации. М., 1983. -63с.

15. Белавин В.А., Булгаков А.З., Нарыкова И.Н., Нугаев Р.Р. Моделирование на ЭВМ - перспективное направление использование ВТ в учебном процессе СПТУ. // Дидактические основы отбора учебной информации и применения ЭВМ в учебном процессе СПТУ. - Л.: ВНИИ ПТО, 1988. с.105-118.